| EE 101	Fall 2008	Date:	Lab Section #
Lab #6		Name:	
Robot Board Sub-System Testing		Partner: No Lab partners this time!	

Abstract

The ECEbot robots have a printed circuit board (PCB) containing most of the control circuitry. The board includes a voltage regulator sub-system, a light-emitting diode (LED) display sub-system, a microcontroller sub-system, and an interface sub-system for the sensors and motors. It is assumed that you have completed the assembly steps as described in *Assembling the ECEBot, Printed Circuit Board: Parts 1 through 3*. You will start sub-system testing in this lab.

Introduction and Theory

Essentially all electronic devices and computers need a DC supply voltage to power the components. The power can come from batteries, from a line-powered DC bench supply, or from an integrated power supply.

The ECEbot circuitry requires a 5 volt DC supply. If we simply tried to use a combination of batteries to create the 5 volts, we would find that the actual voltage would vary as the load changed and as the batteries gradually discharged. This sort of voltage variation would lead to incorrect operation of the microcontroller and other malfunctions. In order to avoid these performance issues, the required constant 5 volts is provided by a special electronic component called a *voltage regulator*. The regulator input voltage (batteries in this case) is allowed to fluctuate up and down with time, as long as it remains at least a few volts greater than 5 volts at all times. The circuitry within the regulator holds the output at a constant 5 volts even as the input voltage or the load changes.

The four PNP-type transistors located just below the display are used as electronic switches: a digital signal applied to the middle terminal of the transistor (the *base*) controls whether or not current is allowed to flow from the upper terminal (the *emitter*) through the device and out of the lower terminal (the *collector*). The four transistor collectors are connected to four common anodes of the LED digits, while the four transistor emitter terminals are connected to the +5V supply, known as V_{cc}.
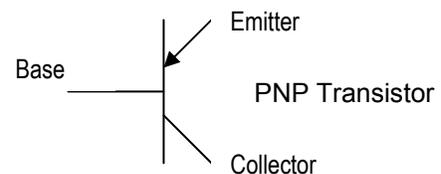
Equipment

Your ECEbot circuit board, your robot parts kit, and the bench power supply, oscilloscope, multimeter, and banana cables furnished in the lab.

Procedures

P1. Verify that you have completed all soldering steps. The front side of the board should have all of the discrete components, switches, red LEDs, 4-digit 7-segment LED display, voltage regulator, and multi-pin headers installed. There will be some empty spots on the board, as noted in Part Three of the assembly guide. Check that the components are oriented correctly and that all pins have been soldered in place.

Have the lab instructor or your lab TA visually inspect your board and soldering, then make any corrections that are required.

Visual Inspection: Instructor/TA initials _____

P2. The first electrical test is to verify the voltage regulator. Later on, seven AA-size 1.5 V batteries connected in series (10.5 V total) will provide power for the robot, but for now the DC bench supply will be used for testing purposes.

→ If a shorting jumper is installed on header **J21**, <u>you should REMOVE IT now temporarily</u>.

→ Set the DC bench power supply to 10.5 V using the DMM to verify the voltage.

   Attach a 4-socket pigtail to the power supply header (**J4**), and a single-socket pigtail to the bottom pin of 2-pin jumper **J21**.

J21 bottom pin is +5V regulator output

+Supply (orange or red)

-Supply (gray or black)
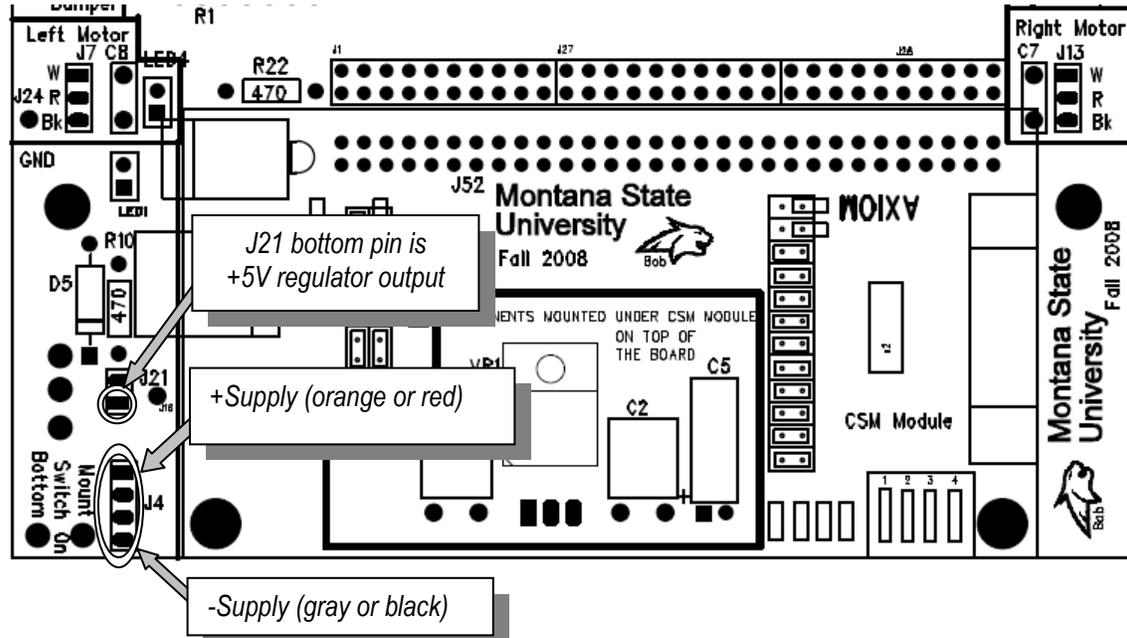
   Connect the positive (red) wire from the supply to the red (or orange) wire of the pigtail using a banana cable and alligator clip. Connect the neutral (black) power supply wire to the black (or gray) pigtail using another banana cable and alligator clip.

   → Flip the toggle switch **S2** to the *up* position. This is the "on" position.

   → The voltage regulator output (5 volts) is sent to the <u>bottom pin</u> on header **J21** in the power supply area of the PCB. Use the DMM to measure the voltage between the bottom **J21** pin and the board ground test pin (**J24 GND**).

   <u>If you do NOT measure 5 volts, systematically check your connections and ask the instructor or TA for help.</u>

P3. With the voltage regulator working, you are now ready to power-up the rest of the PCB.

→ Carefully slide the shorting jumper over the two **J21** header pins: this will connect 5 volts from the regulator to the V_{cc} supply bus on the board. This should illuminate **LED1**, located in the lower left of the board. If the LED does NOT light up, turn off the power supply and re-check all the connections. Seek help if you need it.
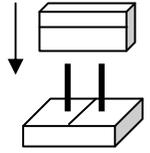
**P4.** Now check the momentary push switches and extra LEDs.

→ In the upper right sector of the PCB, run a single jumper wire from either pin of the 2-pin header **J14** located just above pushbutton **S3** to either pin of the nearby 2-pin header **J18**. With the jumper wire in place, **LED3** should light when you press the button.

→ Next, make a similar connection between pushbutton **S4** and **LED2** in the upper left sector of the PCB: run a jumper wire from either pin of the 2-pin header **J15** to the 2-pin header **J17** near **LED2**. Does the LED illuminate when you press the button? Demonstrate your pushbutton LED switching for the instructor or lab TA.

LEDs and pushbuttons: Instructor/TA initials _____

P5. The last sub-system to check this week is the 4-digit LED display. The display uses two sets of control signals. The *digit select* signals control which of the four PNP transistors is turned on, and the *segment select* signals control which of the seven segments and decimal point within the selected digit are illuminated. The signals are handled by a pair of integrated circuits, the 74LS138 decoder chip and the 74LS47 decoder chip. When your robot is completed the control signals will come from the microcontroller. For testing purposes we will set several control patterns manually using probe wires.

→ Use two medium length black banana cables, alligator clips, and some short wires to make a pair of test probes. Stack both banana plugs onto the black jack of the DC bench supply (see below).
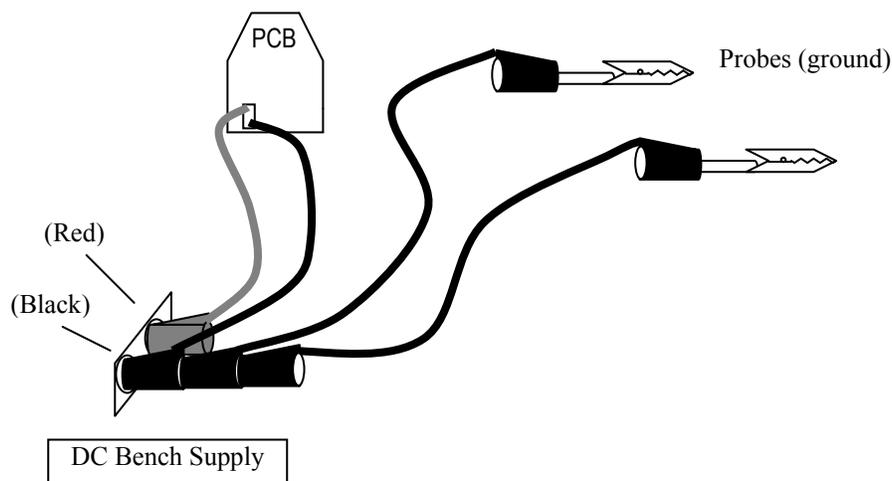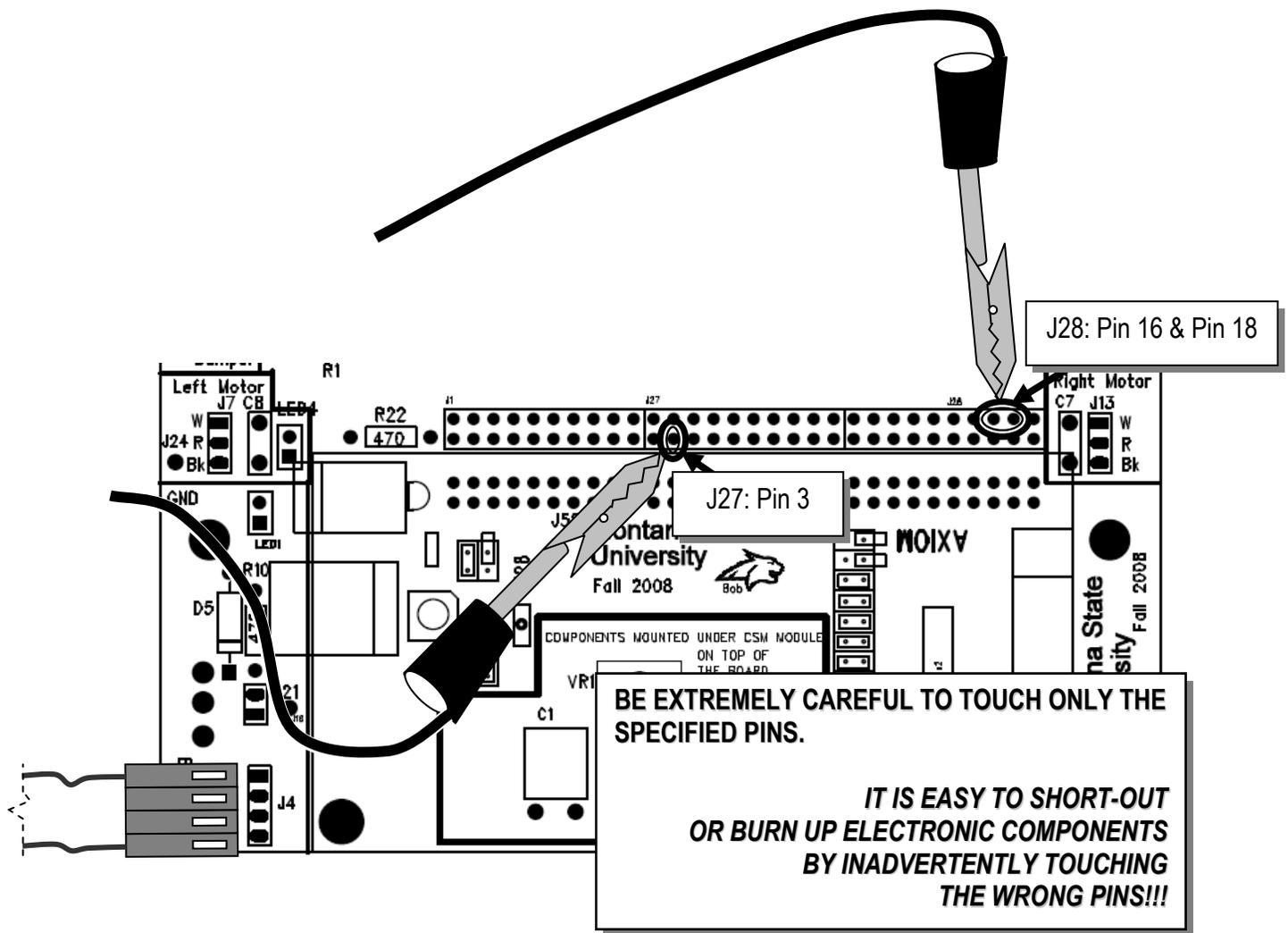
→ Move DIP switch 1 "on" and all the other DIP switches to the "off" position.
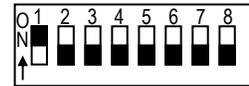
→ Locate the dual row of header pins labeled **J1**, **J27** and **J28** in the middle of the PCB between the left motor and right motor connections. With the power off, CAREFULLY attach a grounded alligator clip so that it touches both pin 16 and pin 18 of the **J28** header (see below). This *segment select* signal will cause the 74LS47 decoder chip to enable all seven segments of the digit. Now simultaneously touch the other probe wire to pin 3 of header. This will cause the 74LS138 decoder chip to forward-bias the base terminal of the digit 1 control transistor. Now switch on the power. Digit 1 (leftmost) on the display should illuminate as "8". If the digit does not light up, switch off the power and check your connections.
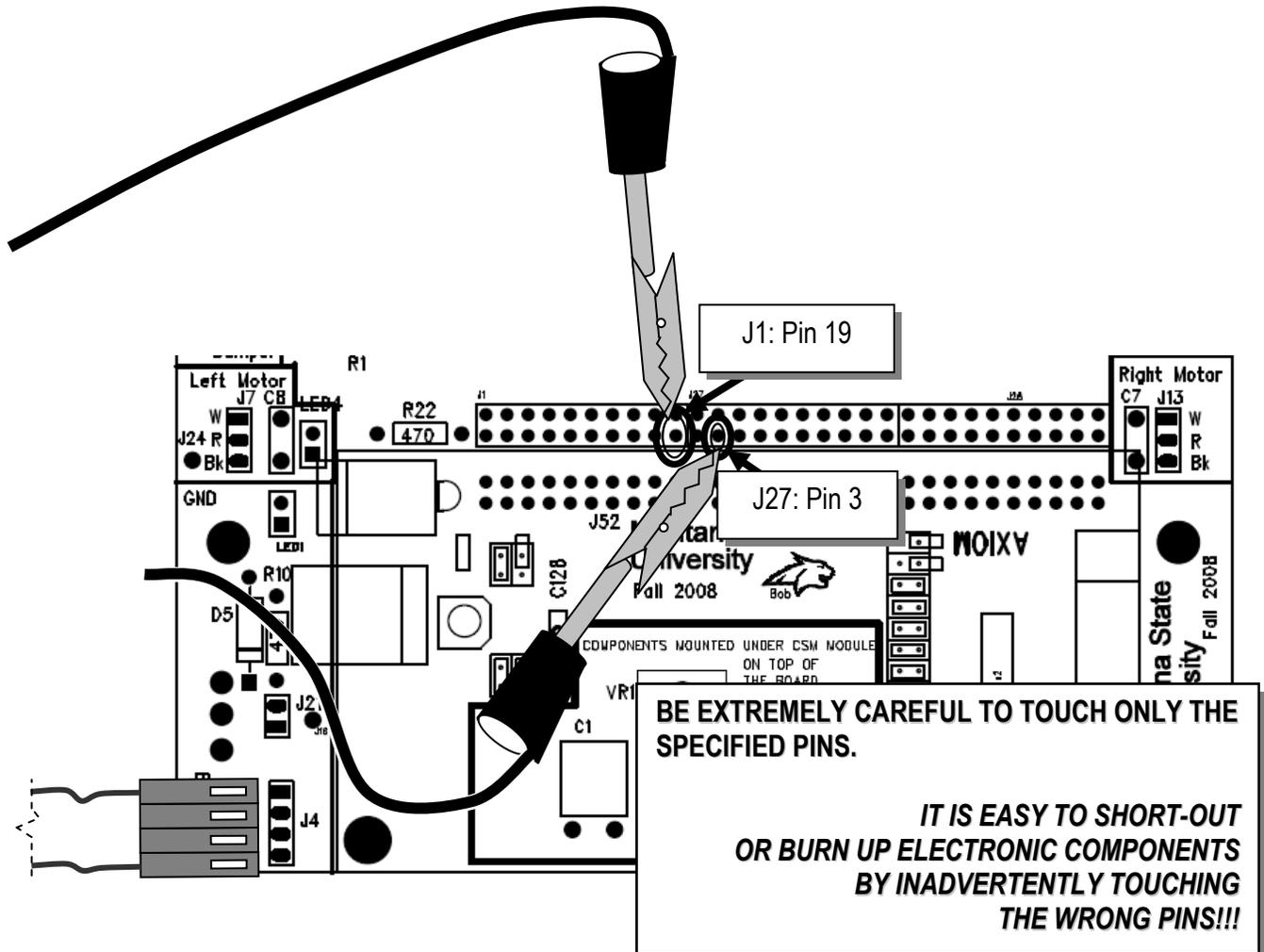
Note: the dual header pins in J1+J27+J28 are numbered this way:

J28: Pin 16 & Pin 18

J27: Pin 3

BE EXTREMELY CAREFUL TO TOUCH ONLY THE SPECIFIED PINS.

IT IS EASY TO SHORT-OUT
OR BURN UP ELECTRONIC COMPONENTS
BY INADVERTENTLY TOUCHING
THE WRONG PINS!!!

→ Finally, keep the grounded wire on **J27** <u>pin 3</u> and move the other grounded wire to **J1** <u>pin 19</u>.

Note that **J1** pin 19 controls the decimal point.

J1: Pin 19

J27: Pin 3

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Demonstrate that you can illuminate the digit and decimal point for the instructor or TA.

LED display probe: Instructor/TA initials _____

Remember: Start the Chassis Assembly construction steps this week. You should have the base plate, motors, wheels, and brackets assembled before the next ECEbot lab. <u>Don't attach the PCB to the chassis yet: you still have a few tests to do during the next lab</u>.